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Gas Journal

VOL. 300 | 111th YEAR | LONDON, DECEMBER 2, 1959 | No. 5022 | PRICE 1/6

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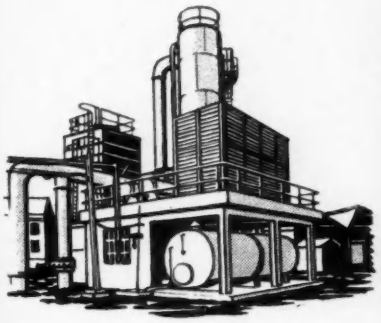

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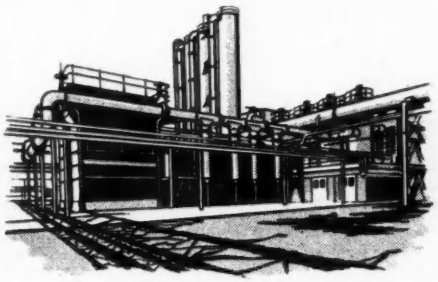

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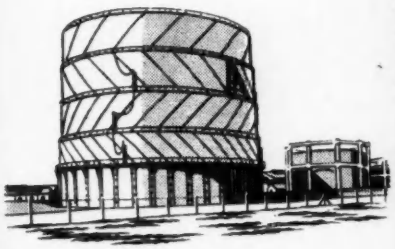
For the Gas Industry



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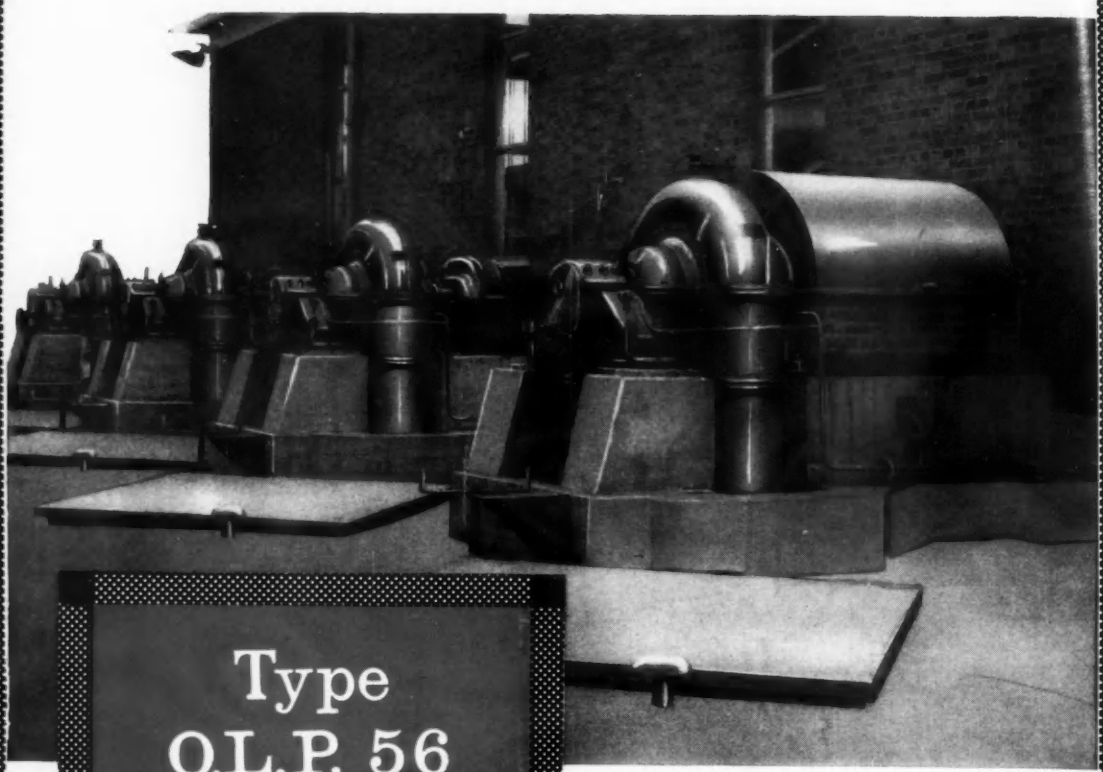

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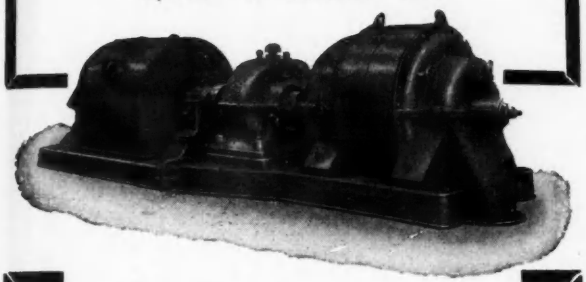

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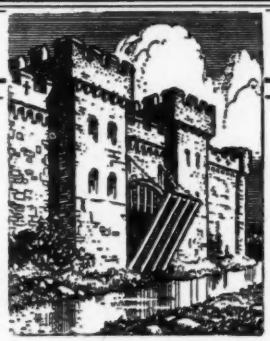

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Gas Journal

111TH YEAR
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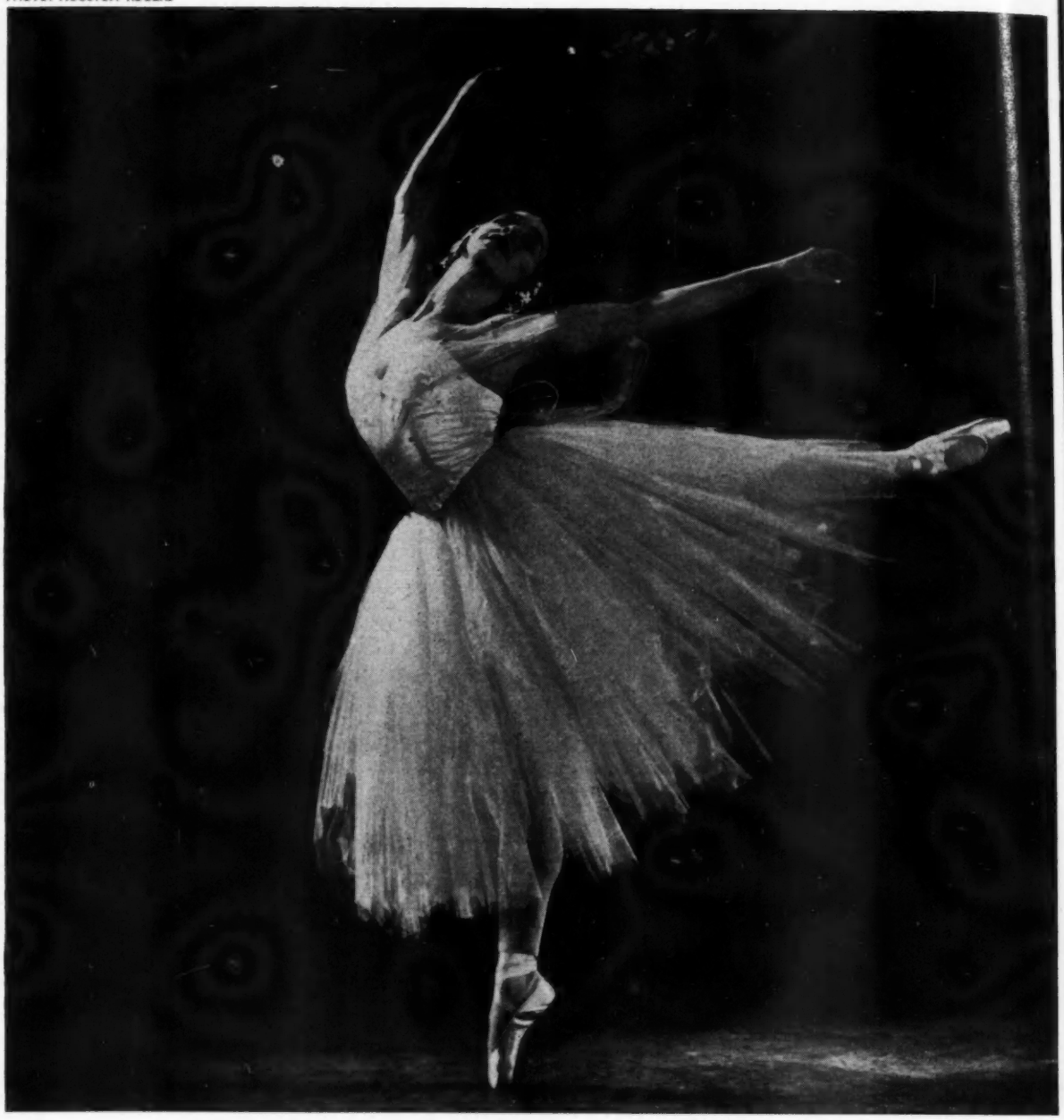

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Gas Journal

VOLUME 300 No. 5022 DECEMBER 2, 1959 111th YEAR

That Fuel Policy Again

THE subject of liquid methane importation continues to act as an irritant to a great many people, not least among whom are those members of the Opposition in the House of Commons who are ever ready to take up the cudgels on behalf of the National Coal Board. The arguments which accompany any mention of methane tend to follow a similar pattern, and the reason for this is simple. It is because *nobody* seems to know anything about the project other than a few bald facts. From the first whisper that such an experiment might be undertaken to the successful transportation of five cargoes there has been something intangible about the whole affair. A real secret never hurt anyone because, to quote a truism, ignorance is bliss; half a secret is an abomination.

For this reason we feel some sympathy for Mr. F. Lee (Labour, Newton) who, speaking during the second reading debate on the Coal Industry Bill, wondered why there was a veil of secrecy over the importation of liquid methane. 'The country is not being told what are the long-term projects of the Gas Council so far as the importation of methane gas is concerned. Indeed, when questions are asked in the House about the ships necessary to import the gas we can never get clear answers as to whether there are under construction the sort of ships necessary for the importation of larger quantities of the gas. I believe that we are entitled to know whether the Gas Council, in particular, intends to extend its importation of methane gas. If it does, I would pose a straight question: What happens to Durham, one of the areas which, if this gas were to become a prime method for the Gas Council to employ instead of Durham's coal, would be in very great danger indeed?'

It is sad to have to report that for all his bluntness Mr. Lee did not receive much satisfaction. Some of his friends on the same side of the House also had a go at Mr. Richard Wood, the new Minister of Power (who, like Mr. John George, the Parliamentary Secretary to the Ministry of Power, was making his maiden speech on behalf of the Ministry), but they tended to strike off on somewhat different paths. Mr. William Jones (Labour, Consett) made a great fuss about the possibility of the new tankers being built by the Japanese and then returned to the point by saying: 'We ask, too, for increased use of coal in the gas industry, and that means restricting the importation of liquid methane. The millions of pounds that have been spent on the building of methane-carrying ships and shore installations would have been better spent on financial inducements to fuel users to install the newer coal-burning appliances.'

And the indefatigable Mr. Woodrow Wyatt (Labour, Bosworth), having referred to the need for a high-pressure gas grid for the whole of the industrial Midlands, and maintained that if this were America and we had an enterprising Government we should already have a high-pressure grid all over the country, also turned to the expenditure of money on improving the fuel balance. 'Nobody seems to know whose responsibility it is to spend money on research,' he said, 'and nobody seems to care. Mr. Wynn, the scientific member of the National Coal Board, has suggested that it is not the business of the Board to do research into the use of coal. The Electricity Board and the Gas Council have also stated that it is not their business. Whose business is it to provide adequate research facilities for our basic industry, which has a turnover of £900 mill. a year?'

To all of this the Parliamentary Secretary replied: 'The Gas Council is still experimenting with liquid methane and my right hon. Friend still awaits plans. No plans have yet been made. Experiments are still going on and the gas industry is not committed to building ships of any kind. That is the position today.' Which did not really tell anybody anything and certainly could not have satisfied the irritated Mr. Lee.

Another hardy annual at debates of this kind is whether or not we need a 'national fuel policy,' a phrase which is coming to be associated with those who favour giving a helping hand to the struggling N.C.B. Earlier in the debate Mr. Roy Mason (Labour, Barnsley) asked: 'Does the Minister not consider it most important to have a meeting immediately, in view of the level of the industry and especially having regard to the large-scale imports of oil and the possible large-scale imports of liquid methane? Should he not call together the chairmen of the gas, coal and atomic energy industries

and, possibly, electricity, as well as the oil industry, and ask them to use their fuel and power resources in the best interests of the nation before we become too dependent upon imports of oil and liquid methane? '

To which the Minister replied smoothly that he would certainly call the chairmen together if necessary.

This, we feel tempted to say, is where we came in. The argument, like one of those fussy miniature trains in a children's playground, has chugged energetically round its usual prescribed circle and returned to the starting point. Nobody got anywhere but some people enjoyed the ride.

And yet one cannot entirely dismiss the question of a co-ordinated fuel policy by quoting the time-honoured answers about fuel prices finding their own levels. The fact still remains that coal, electricity, gas and oil are all necessary to our future prosperity and no excessive price disadvantage should be permitted any one of them if it endangers a future in which that fuel may reassert itself and meet a genuine need. We think the Government is right to be hesitant about meddling with the natural free-for-all of competitive fuel prices, and to resist the pressure exerted by those who would do for the Coal Board what it could and should do for itself, but that does not mean that the principle of adjusting the scales is necessarily wrong.

Some of the reasons why such an adjustment would be a difficult, and if mishandled, a dangerous, undertaking were mentioned in a *Times* review of a paper by M. van den Heuvel, head of the energy division of the O.E.E.C. recently. Speaking of how prices of fuel and power should be determined to ensure comparability, this points out that there are complications and adds: 'For example, the expanding use of electricity has facilitated the use of better and bigger units of plant, with great savings in costs, whereas the slower expansion of gas consumption has given less scope for new plant, and the cost of making gas by new methods on a very large scale is hardly known for certainty. Prices cannot yet reflect it. Gas, not least because it can be stored, has marked advantages for certain types of heat; but its attractiveness cannot be fully compared on a price basis with that of electricity under comparable technical conditions. This is presumably the kind of problem which a fuel policy should provide for. But there is no sign that anyone is concerned to do so.'

Success with a 'New' Load

ONE of the pleasures offered to the electricity industry every now and again is the opportunity to exploit an entirely new load. The limited forms of utilisation open to gas make such opportunities comparatively rare, but during the past year or two the chance has come and the gas industry has plunged into the fray with alacrity. The new load we have in mind is central heating—which is only really new in as much as the creation of favourable tariffs and the evolution of the small-bore system have rejuvenated a type of business which has existed for years—and warm air heating. The pace at which the industry's salesmen have got cracking has been limited only by the time taken to learn the technique, and to be fair, that has not been very long.

As is generally known, it was the South Eastern Board which blazed the trail, and it was some time before its neighbour, the North Thames, produced a tariff designed to attract this type of business and entered the lists in a big way. Since the introduction of the latter's 'cheap gas' tariff (quarterly standing charge of £3 and gas for all domestic purposes at 1s. 4d. a therm) this Board has gone all out to build up its central heating and warm air business. At their Central Heating Convention last June the Board's Sales Manager, Mr. J. A. Buckley, set a target of 1,000 central heating and hot water boilers to be in and working for this heating season. That target has been achieved. At the week ending November 8 the sales total stood at 1,115.

How has this been achieved? We have recently had an opportunity of examining details of the campaign, which has been marked by an unusually compelling series of advertisements, a highly successful exhibition and the help of a section of the Board's network of dealers. Advertisements in the London evenings brought in 900 coupons (compared with 934 for the S.E.G.B. who shared the campaign); an exhibition at Woodford produced 69 firm enquiries and such orders as one for an estate of 18 houses to be equipped with gas-fired boilers.

Incidentally, evidence of the growing popularity of gas-fired warm air units was given by Mr. Niel Wates, of Wates Ltd., who told the Federation of Registered Housebuilders' Conference that his company's policy is to install these units in houses from £2,000 to £5,000; they have rejected oil-fired central heating because it has given a lot of trouble and electric under-floor heating on the grounds of its inefficiency.

Gas and the Poetry Industry

YO ho ho and a bottle of liquid methane! Who would have thought that a tanker would, so to speak, set fire to the imagination of the puzzle-setters of that revered weekly, the *New Statesman*? Here art and the sciences come together with a sickening thud. The contest, which is for amateur parodists and satirists, is usually good for a refined laugh, but it has never been on the explosive level. Competitors were invited to submit a sea shanty for the crew of the Methane Pioneer. The comment with the results was that many of the entries favoured a 'blow the man up' approach. Examples:

'And I'll blow you all to Hell,' says Mr. Therm,
and
You gotta be certain the darn thing won't blow,
Oh close the valve tight Johnnie, close the valve tight.

But truly remarkable was the absence of puns. An exception was 'What shall we do with redundant miners/ Oily in the morning?' Oh well, perhaps one is better without them. Puns, we mean. If the gas industry goes on like this, getting unwonted attention from intense word-spinners, we shall soon have block requests for tickets for the Autumn Research Meeting from, say, the Theydon Bois Æsthetics of Rhetoric Group. Contribution to discussion: 'Would the author tell us his dawn thoughts when he discovered c.v. had flopped 30% during the night?'

One competitor, far from showing the gleeful morbidity of the previous examples, was positively well-informed:

The stink of the coal gas will plague you no more.
We soon shall have filled every single gasholder
With C_2H_6 or with pure CH_4.

But on the whole, this literary competition failed to show signs of any imminent Meterphysical Renaissance.

Personal

MR. THOMAS G. ELLISON and MR. ARTHUR E. SKAN have been appointed joint Managing Directors of George Ellison Ltd., manufacturers of electric switchgear and motor control gear in Birmingham. Mr. Ellison is a son of the founder of the company, the late Mr. George Ellison, and has been a director since 1929. He was elected chairman of this and of the associated companies, Alfred Ellison Ltd. and Tufnol Ltd., in 1955. Mr. Skan has been a director of all three companies since 1944 and is Managing Director of Tufnol Ltd. He is a past chairman of the British Plastics Federation and a member of the Grand Council and the Midland Regional Council of the Federation of British Industries.

MR. LEONARD HAYWARD was presented with a refrigerator and a long-service certificate, and MR. WILLIAM GARLAND with a cheque and a long-service certificate, at a recent ceremony in Taunton (Somerset). Both men have retired with nearly 100 years service between them. Both these presentations were made on behalf of the Board by the Area Development Manager, Mr. T. N. Dent. Mr. Hayward, once chief clerk of the Bridgwater Gas Company, moved to Taunton and became clerical assistant to the sub-divisional commercial assistant. Mr. Garland returned to the Taunton Gas Company after the first world war as a maintenance fitter and also served for a number of years as a meter reader.

Diary

December 3.—WALES AND MONMOUTHSHIRE JUNIORS, NORTH WALES SECTION: King's Head Hotel, Holywell. Paper by I. F. Carless. 3.p.m.

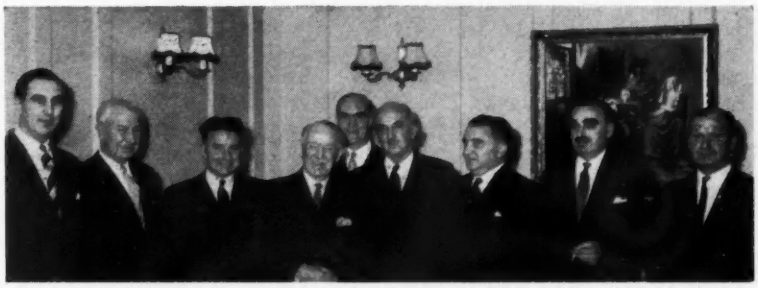
December 3.—SOUTH WESTERN G.C.C.: Taunton. Council Meeting at 11 a.m.

December 3. — I.G.E. NORTH OF ENGLAND SECTION: Grainger Street, Newcastle-upon-Tyne. 'Telecommunications in the Gas Industry,' by G. M. Rimmer. 2.30 p.m.

December 3.—THE INSTITUTE OF FUEL, MERSEYSIDE SUB-SECTION: Liverpool. 'Automatic Boiler Control.' 7 p.m.

December 4.—I.G.E. MIDLAND SECTION: College of Technology, Gosta Green, Birmingham. Special meeting including a précis of a paper entitled 'The Continental Uses of Gas in Industry,' by T. Ward, Assistant Industrial Gas Officer, North Eastern Gas Board. 2.30 p.m.

December 4.—THE INSTITUTE OF FUEL, SOUTH WALES SECTION: Cardiff. 'Under Fire'—coal, gas oil, electricity, iron and steel. A panel of five experts will answer questions.



Former pupils pay their tributes

A unique dinner party recently took place in Porthcawl (Glam.), when eight former pupils, with their ladies, joined in paying their tribute to Mr. W. Clark Jackson, M.B.E., and to Mrs. Jackson.

Mr. Jackson, who was formerly the engineer and manager of the Neath Corporation gas undertaking, and chairman or director of a number of gas companies, is widely known as a gas engineer and manager. Although he retired some years ago from his appointment at Neath, he retains his close connection with the gas industry in his capacity as Chairman of the Pembrokeshire group of undertakings of the Wales Gas Board, and as Consultant to the Board on coal and coke matters.

The former pupils present were: Mr. F. Dupont, Engineer and Manager, Brecon undertaking, Wales Gas Board; Mr. E. M. Edwards, Deputy Chairman, Wales Gas Board; Mr. V. Hutchins, Assistant Engineer, Wisbech undertaking, Eastern Gas Board; Mr. D. W. Rees, Engineer and Manager, Llanelly undertaking, Wales Gas Board; Mr. A. W. Richards, Coal, Coke and By-Products Officer, Wales Gas Board; Mr. A. L. Thomas, Engineer and Manager, Haverfordwest undertaking, Wales Gas Board; Mr. Gwyn Thomas, Industrial Gas Engineer, Eastern Gas Board, Watford, and Mr. I. W. Thomas, Engineer and Manager, Aberystwyth undertaking, Wales Gas Board. The ninth 'old boy,' Mr. Julian John, who is a gas engineer with the East Midlands Gas Board at Derby, was unable to be present.

Writing desk present

In the course of the evening, the guidance given during the early years, and the fatherly interest and friendship which Mr. Jackson had subsequently manifested in his pupils, was recorded; his gift of imparting to those under his direction the knowledge of one accepted as an authority, was acknowledged: it was in that spirit of indebtedness and thanks that the function was arranged. To mark the occasion, Mr. and Mrs. Jackson were presented with a writing desk. In accepting it, Mr. Jackson thanked his hosts for a wonderful and memorable evening. Mrs. Gwyn Thomas, at one time secretary to Mr. Jackson, presented to Mrs. Jackson a bouquet of flowers for herself and her daughter.

Additional duties

Mr. Dupont is also Chairman of the Brecon Group Committee of the Wales Gas Board; Mr. I. W. Thomas is also Chairman of the Cardigan Bay Group Committee of the Wales Gas Board and Mr. D. W. Rees is also Convenor of the Swansea Group Committee of the Wales Gas Board.

Lurgi plant approved

THE Minister of Power, Mr. Richard Wood, said in the House of Commons yesterday that he had approved the Lurgi complete gasification plant scheme for the West Midlands Gas Board at Coleshill.

Mr. Wood was answering Mr. Gordon Matthew, Conservative member for Meriden, who had asked the Minister to state his policy with regard to approval of the Board's general programme of capital development. Mr. Wood replied that he had approved the programme, which included the Lurgi scheme.

The plant would, he said, consume about 400,000 tons of non-carbonising coal a year, supplied from pits in the Midlands area.

December 5. — SCOTTISH WESTERN JUNIORS: Albany Street Social Club, Edinburgh. 'Coals for Complete Gasification Purposes,' by Dr. E. A. C. Chamberlain and Dr. Brookfield. 3 p.m. Joint meeting with the East of Scotland Association.

December 8.—THE INSTITUTE OF FUEL, MIDLAND SECTION: Stoke-on-Trent. 'Waste Gas Corrosion,' by Dr. G. Whittingham. Joint meeting with North Staffs. Fuel Society. 7 p.m.

December 8.—LONDON AND COUNTIES COKE SALES CIRCLE: Open Forum on Coke at Home.

December 8.—MIDLAND JUNIORS: Birmingham. Joint Meeting with Wolverhampton and District Engineering Society. 'The Use of Primary Flash Distillate in a Water Gas Plant,' by Messrs. J. V. Craddock and R. W. Hind. 6.30 p.m.

The Chairman of the Eastern Gas Board, Mr. J. H. Dyde, the Deputy Chairman, Mr. F. T. Brookes, senior officers of the Board—and one special guest at the entrance of the new H.Q., Sun Building, Watford, photographed during Sir Harold Smith's visit to Tottenham. The guest is Mr. F. C. Greenhough (extreme left, second row), who was chauffeur to Sir Harold when he was at Tottenham. Mr. Dyde and Mr. Brookes are respectively right and left of Sir Harold.

Sir Harold revisits his Tottenham 'home'

A NOSTALGIC DAY FOR EX-SUPERINTENDENT WHO REACHED THE TOP

SIR HAROLD SMITH, who is retiring from the Chairmanship of the Gas Council at the end of the year, has visited Tottenham at the invitation of the Eastern Gas Board. He renewed acquaintance with old friends of the former gas company, which he served in the years before nationalisation, and received two presentations as a mark of esteem and appreciation of his services to the industry.

Presentations

At a lunch at Woodall House, head office of Tottenham Division, Sir Harold was entertained by the Chairman and Deputy Chairman, Mr. John H. Dyde and Mr. Frank T. Brookes, members of the Board, and officers who were associated with Sir Harold during his Tottenham regime. Mr. Dyde presented Sir Harold with a set of cut crystal glasses.

Later at the G.A.S. Club, Willoughby Lane, a presentation was made of some silver candelabra, subscribed for by employees, from divisional works and offices, who had worked with Sir Harold. The presentation was made, before a large representative gathering, by Mr. Henry Wadsworth, Divisional Engineer, supported by Mr. Harry W. Merrison, Divisional Service Manager.

Headquarters visit

It was in 1920 that Sir Harold went to Willoughby Lane works, the largest gas manufacturing station in the Eastern area, as superintendent. In 1922 at the early age of 32 the Tottenham Company made him their chief engineer and later he became general manager with a seat on the board. Finally he was appointed deputy chairman of the company.

Between the two presentations Sir Harold toured Willoughby Lane works and met employees who have worked there for more than 40 years and remembered his being in charge.

Earlier Sir Harold visited the Board's new headquarters at Watford.

Recently Sir Harold paid a last official visit to Wales. He was entertained by the Wales Gas Board to dinner where he met Board members and chief officers together with representatives of the staff and manual workers. Sir Harold was presented with a painting by Kyffin Williams of 'Snowdon from Gelli Iago.' The painting will serve as a reminder of many happy visits that Sir Harold and Lady Smith have made to this part of Wales, for which they have such a great affection.

Gas Consultative Councils

GOVERNMENT SUBSIDY FOR PROJECTS MOTION REJECTED BY MINISTER

THE Government would not consider subsidising the price of gas. This is one of the points made in a letter sent to the **Scottish** Gas Consultative Council by the Minister of Power in answer to suggestions made by them in a resolution.

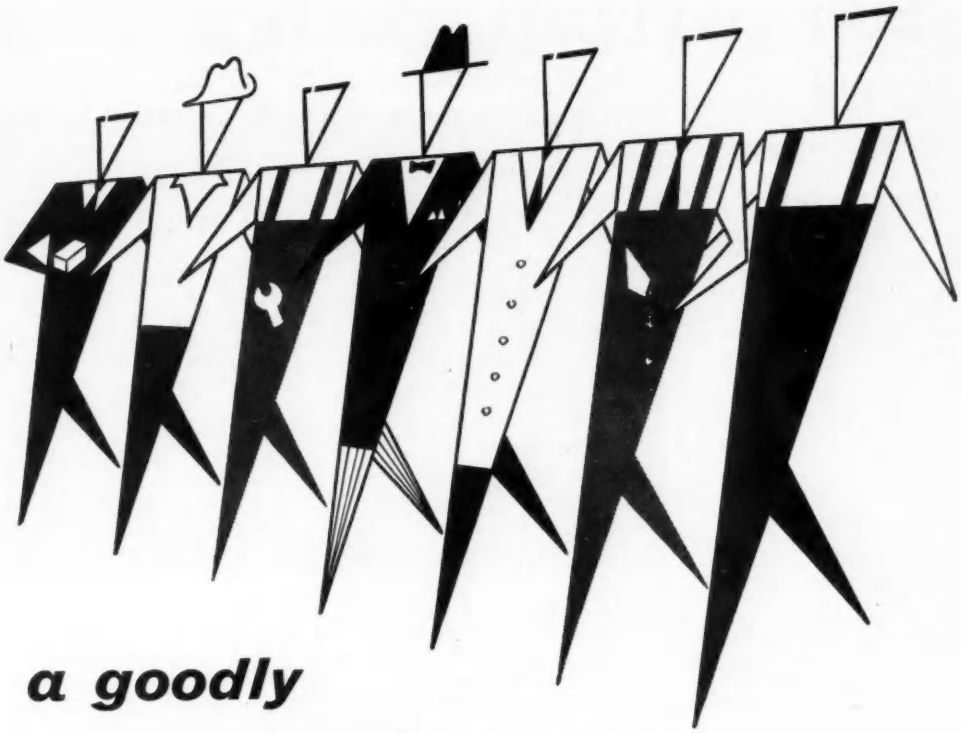
The resolution had recorded the Council's opinion that the interest charges on exceptional projects such as the Lurgi installation at Westfield should, during construction, be capitalised, and that no interest should be charged against revenue until the project was in operation. In order to prevent the industry from pricing itself out of existence and to maintain stability in prices, the Government should afford financial assistance to avoid increases in the price of gas.

The Minister replied that the terms of the Gas Act would almost certainly preclude the adoption of either suggestion so that neither could be introduced by administrative action. Further legislation would be necessary.

About capitalisation of interest by nationalised industries, the Minister stated that he was not aware of any wish on the part of the gas industry to have this facility extended to them. Moreover, while he appreciated the problems facing the Scottish and other gas boards, he did not consider they were really comparable with those which gave rise to the legislative provisions in the case of the North of Scotland Hydro-Electric Board and British Railways.

This Minister added that subsidising the price of gas would imply a reversal of the basic principle that nationalised industries should cover their costs taking one year with another, which had been accepted by both major political parties and embodied in the nationalisation statutes.

The **North Eastern** G.C.C. has expressed 'strong dissatisfaction' at the area Board's refusal to alter the form of some of its tariffs which, the Council felt, put the price of gas more heavily on one type of consumer than on another; while the increased prices announced a few weeks ago represented a 5½% increase to some big users, to smaller users it was an 8% rise.



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BIGGEST WELDED HOLDER IN U.K.

Work will cost £460,000, take two years

THE biggest all-welded gasholder in Britain is to be built for the East Midlands Gas Board by the Oxley Engineering Co. Ltd. at the Board's Litchurch gasworks, Derby. The cost of the whole project, including the gasholder construction, will be £460,000.

Work will start within the next few weeks and will take about two years to complete.

The new holder will have a gas capacity of 6 mill. cu.ft. and will replace three old holders at Litchurch which have a combined capacity of under 2 mill. cu.ft. Two thousand five hundred tons of steel and over 1 mill. ft. of welding rods will be used in building the new 230-ft. holder.

A spokesman for the Board told the 'GAS JOURNAL' that the new holder would take its place at Litchurch as an important part of the main storage capacity of the Board's backbone main, aiding the supply to over half of the Board's area, which stretches from Chesterfield in the north to Stony Stratford in the south.

The operation of the holder will be controlled from a central control room at Litchurch where the gas supply to the 550 miles of grid system, together with vital information concerning stocks and pressures, are dealt with.

Oxley Engineering Company have also been contracted to build a 150-ft. high gasholder at the Board's Basford works, Nottingham. Work on this project, which will total about £230,000, will start early next year.

The new holder will have a gas capacity of 3½ mill. cu.ft. and will replace a holder built in about 1880 of under 2 mill. cu.ft. capacity.

The holder will help serve about 40,000 gas consumers in the north and north-west areas of Nottingham and will also form part of the integrated backbone main grid supply system.

£80,000 pipe-line improvements scheme

An £80,000 gas pipe-line improvement scheme to take bulk supplies of gas from Rotherham to *Maltby*, is being undertaken by the East Midlands Gas Board. The pipe-line will be joined to the Rotherham-Doncaster main at Whinney Hill, Dalton, and run through Hellaby to the Tickhill Road holder station at Maltby. It will be fed by the Manvers Main coke oven plant.

Branch mains will lead off to Bramley, Wickersley, Ravensfield, Ravenfield Common and Thrybergh. A total of about 30,000 people will be served by the new scheme.

Picture shows judging in progress for the competition. At the head of the table is Mr. A. V. Horsfall, Sales and Service Manager of the West Midlands Gas Board, who was Chairman of the judging panel. The judges were Madame S. B. Prunier, the well known restauratuer, Mr. P. H. Venning, Catering Superintendent to the Queen (next to Madame Prunier); Mr. S. E. Pocock, Catering Manager, South Eastern Gas Board (next to Mr. Horsfall) and Mr. H. R. Duffield-Harding, Chairman of the Cookery and Food Association. Mr. A. S. Williams, of the North Thames Gas Board, who acted as the judges' Secretary, sits at the foot of the table.

'Plan a Kitchen' competition

'FULLY up to professional standard' was the judges' verdict on the first five entries in the Gas Council's recent 'Plan a Kitchen' competition. The competition, for a kitchen serving 250/300 lunches and/or dinners a day, was open to catering students and people whose catering training was completed since the beginning of last year. It was originally intended that the first prize-winner should receive £50, and that the second and third prize-winners should receive £30 and £20 respectively; 20 £10 prizes were also to be awarded.

However, there was great difficulty in selecting the third prize-winner and the judges asked if some special commendation could be made to the students whose entries were placed four and fifth. The Gas Council decided to award prizes of £15 each to these two competitors and there will be 18 £10 consolation prizes.

. . . and 'The Young Hostess'

THE NORTH WESTERN GAS BOARD also held a competition recently. Sixteen champion teamakers, the finalists from over 120 girls from grammar and secondary modern schools in the North West, appeared on the stage of the Free Trade Hall, Manchester, in 'The Young Hostess' contest organised by the Board and the Ceylon Tea Centre, London.

The theme of the competition, the first of its kind on a large scale to be held in this country, was good tea-making and the correct and attractive etiquette of serving it. The senior girls also had to cook a Ceylon jewel cake, and the juniors some coconut biscuits.

The stage at the Free Trade Hall was furnished with a row of gaily-coloured cubicles, each with its table and gleaming gas stove. Above them all was a gigantic Mr. Therm and a score-board showing the girls' names and the marks they were being awarded for such matters as correct infusion, the right amount of tea, etc.

Mr. Jon Pertwee, the TV and radio star, acted as compere.

Miss H. Swindells, Chief Home Service Adviser of the Board and Mrs. D. P. Welman, wife of the Chairman, were present, with Mrs. D. M. Forrest, wife of the Commissioner of the Ceylon Tea Centre.

The winners were awarded educational grants of £50, and these and other prizes were presented by the High Commissioner for Ceylon, Mr. P. R. Gunasekara, who was thanked by Mr. D. P. Welman, Chairman of the North Western Gas Board.

25th AUTUMN RESEARCH MEETING

The Connersville Meter—under Test and in Operation

By

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PLANNING ENGINEER,
NORTH THAMES GAS BOARD

UP to the beginning of the second world war, positive wet drum meters were mainly used for measuring town gas. The accuracy of these could be checked regularly in position, and their maintenance was well understood. Difficulties in obtaining the necessary craftsmen with ability to repair the sheet metal drums has, however, prevented their continued use, and, as these meters came to the stage of requiring either new drums or major overhauls, it became necessary to replace them by Connersville meters. Although these have been used both in America and Europe, for many years the same detailed knowledge of their testing and operation has not been available to gas engineers.

As is well known, Connersville meters are based on the design of the 'Roots blower,' except that the impellers are of a more exact epicycloidal profile and are machined to a very close tolerance. The impellers rotate in a similarly accurately machined cast iron casing, and the fact that all the boundary faces of the measuring chambers are robust and have machined surfaces indicates the probability of maintained accuracy. The only apparent 'variable' appears to be the small volume of 'slip' gas that inevitably passes through the fine clearances between the impellers and between the impellers and the casing. The makers claim that at normal loads this is less than 1% of the 'swept volume' of the meter.

For testing, the makers recommend their so-called 'slip test.' This consists of determining the differential pressure across the meter at, say, quarter, half, three-quarters and full load, and then, with inlet and outlet valves closed, rotating the meter by hand to reproduce these pressures; the speed of rotation is noted. From the known swept

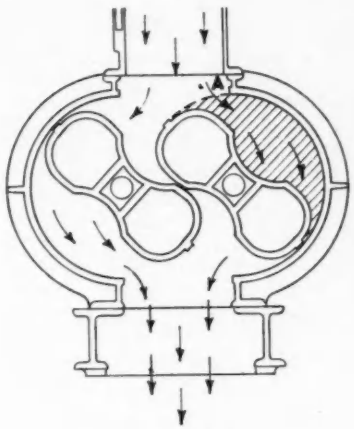

Fig. 1.

volume per revolution, the determined speed of rotation can be converted into a value denoting volumetric flow. The makers state that the volume of gas slipping at working speed is half this figure, and claim that the percentage accuracy can thus be calculated from a simple test readily made *in situ*.

Ignoring for the moment the empirical statement requiring the determined slip to be halved, there is no doubt that

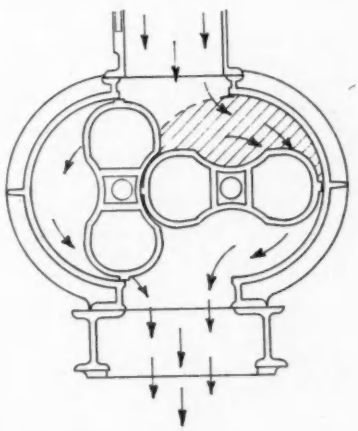

Fig. 2.

Abstract and discussion of a paper presented to the Institution of Gas Engineers in November.

this test does give a relative check on the condition of the meter and particularly calls attention to any *change of accuracy* since the previous test; it is therefore very useful.

In the author's opinion, the claim that this test really shows the volumetric accuracy of the meter has no scientific foundation. It was therefore felt that examination of the factors controlling the accuracy of Connersville meters was called for, and that the results would be of general interest.

The volumetric efficiency of all positive measuring devices falls off with increase of speed, due to the difficulty of filling the measuring chamber completely at high speeds. The normal station meter with water-sealed drum is particularly limited in this respect and its speed is usually limited to 100 revolutions per hour. This is due to the rapid flow of water from chamber to chamber, which involves turbulence, and also to ' wiredrawing ' as the inlets and outlets become sealed in the water surface.

Inspection of Fig. 1 would at first sight indicate that this latter effect occurs in a Connersville meter at point A as the impeller closes the gas inlet. Fig. 2, however, shows that the ' swept volume ' (shown shaded) is already full of gas at a point 90° earlier; hence, there is no flow of gas, with consequential wiredrawing at point A. This is a very important advantage to this type of meter. It indicates that the meter can operate at high speeds and still maintain accuracy, and as will be seen later, this quality has been fully confirmed under test.

All the work indicates that this type of meter is capable of operating well at full load and that its accuracy shows no sign of depreciating at 100% overload, though, obviously consideration must be given to the mechanical stresses under these conditions. If the meter is well maintained and clearances are small, its accuracy should be maintained down to 10% full load and should not exceed a figure of 1% slow at this load. Below 10% the accuracy very rapidly depreciates.

It is now standard practice for all new North Thames meters, and also for any meters removed from their foundations for overhaul, to undergo this thorough test and examination before being installed on their permanent foundations.

When a meter has been installed and put to work, a slip test is taken and repeated at least yearly. At the same time as this yearly test is carried out, a special check is made on lubrication, play in bearings, or in gears, and particularly a check is made that the meter operates quickly and smoothly at full load. This yearly test indicates any change in accuracy and whether any special treatment is required.

In conclusion, it can be fairly stated that, by the methods outlined, the relative accuracy of the hundred-odd Connersville meters employed in the works of the North Thames Gas Board has been maintained from year to year and that by the use of this additional volumetric accuracy test a direct comparison with a volumetric standard is now possible.

In the paper the makers' ' slip test ' is investigated and methods of examining, testing and maintaining Connersville meters are summarised. An appendix presents a normal full report of the examination and test of a new meter.

DISCUSSION

Mr. J. A. Hepworth, North Thames Gas Board, said: The background to this paper is the progressive displacement during the past 20 to 30 years of the bulky and expensive standard type station wet meter by the cheaper, smaller and relatively high-speed Connersville meters which are now almost entirely responsible for the volumetric registration of our gas and which form the basis for the assessment of our process efficiencies. The large water-seal drum meter gave us long years of satisfactory service and, as we are able to apply a volumetric test to this type of meter without much difficulty whenever we require it, we felt we were in command of the registration of gas production and that the recorded measurements were generally reliable and formed a sound basis for assessing technical efficiencies.

Our experience with the Connersville meters has been generally satisfactory and they have given excellent service but occasions have arisen when the accuracy of the meters has been in doubt, either as a result of unusual mechanical features or possibly because of some other gas production results. It was felt that though we had no reason whatever to lose confidence in Connersville meters it was desirable to cultivate a more basic knowledge of their accuracy under varying conditions in mechanical operation and gas loading, and in particular to apply a volumetric test whenever it was considered necessary.

Satisfactory Results

In other words, we wanted to feel that we were in command of the situation in respect of volumetric registration, and that whenever any serious doubt arose we could satisfy ourselves of a meter's accuracy by applying positive and inferential tests. For these reasons the Beckton test station was established. The fundamental studies were both involved and tedious and required the well-known enthusiasm of the author and the fullest collaboration of the Board's meter department to achieve satisfactory results.

It has been possible to determine the volumetric accuracy of meters at varying loads and to relate the results to the clearances between the impellers and the casing, and it has been established that at the clearances which are considered desirable these meters give almost constant accuracy between 20 and 150% of full load. This is not so if the clearances are excessive, and this means that gears and bearings must also be in good condition.

The author mentions the use of epoxy-resin paint for the coating of impellers and to reduce impeller clearance and the slipping of gas. This has proved useful in some cases where clearances have been excessive, but the period of its effectiveness is not precisely known and it is not a satisfactory substitute for the good machining and assembly required in manufacture to establish the desirable clearances in impellers and casing.

With the meter record card available, any deviation from the test of volumetric accuracy of the meter can be detected at the *in situ* annual examinations and slip tests. The result of the work of the testing station confirms that the Connersville meter should be regarded as a machine and should receive proper attention and be kept in a good state by mechanical maintenance. It will then give accurate measurements.

The requirements for good meter operation, emphasised by the work of the test station and applied at the various works, is reflected in the results of the annual *in situ* tests of the Board's Connersville meters and there has been a progressive reduction in the first few years in the number of meters showing appreciable deviation from accuracy.

To summarise, therefore, I believe that the testing station at Beckton has fully justified itself and essentially pinpointed two important facts. First, it has shown that it is possible to apply a satisfactory positive volumetric test to a Connersville meter the results of which can be used in conjunction with the annual slip tests to show any deviation in meter accuracy. We have therefore succeeded in making available to ourselves positive information on the accuracy of any Connersville meter. Secondly, it has been shown that a Connersville meter has a constant accuracy over a wide range of load provided the impeller

and impeller-casing measurements do not deviate from the desirable standard measurements.

Clearly the Connersville meter is a machine and should be regarded as such. It should be supplied to specific limits of accuracy, an accuracy of clearance between impellers and between impellers and casings. If it is treated and maintained as a machine it is capable of giving completely satisfactory service under sustained and appreciable overload conditions.

It is intended to continue the use of the testing station at Beckton, primarily to test new meters and assure ourselves of their satisfactory condition and performance and to establish the meter record card as a basis for subsequent annual examination.

Mr. H. Whiteley, W. C. Holmes & Co. Ltd., said: The author suggests that one reason why wet station meters were superseded by Connersville meters is the difficulty of obtaining craftsmen to produce and replace drums. But I suggest that in addition the item of cost also entered into it. It was usually possible to put in a Connersville meter having an increased capacity to that of the drum-type meter at less than the cost of repairing the drum, and at the same time occupy considerably less floor space.

With regard to the statement that 'Up to the beginning of the second world war, positive wet drum meters were mainly used for measuring town gas,' I think the following statistics may be of interest. Up to August 1939 we had sold a total of 628 meters to gas undertakings here and overseas and, of course, to coke ovens and steelworks also, and the rated capacity of those sold to gas undertakings in this country amounted to a total of 804 mill. cu. ft. of gas per day. The Ministry of Power statistics reveal that in 1939 approximately 850 mill. cu. ft of gas per day were made by gas undertakings in Great Britain.

It was, of course, the custom to put in a meter which would take care of future increases in gas makes. Even so, unless many people were metering gas more than once on their works, as for example with a c.w.g. meter and a total gas meter, a substantial proportion of gas sent out in 1939 was passing through a Connersville meter.

Dealing now with the empirical nature of the slip test referred to in the paper, we have never implied that this was based on a scientific foundation. It was in fact based on experiment and, while we were aware that the divisor of 2 was not strictly accurate for all meter speeds, it was in fact substantially confirmed by many tests. I think that this is adequately confirmed by the statement referring to the velocity of efflux of gas at full load speed.

Large Capacity Testing

It may be interesting to mention at this point a prover put in by our licensors in America having a capacity of 2,800 cu. ft. In order to obtain as high a degree of accuracy as possible the inside of the casing was hand scraped, a gauge being used to determine the exact diameter. This gauge, incidentally, was sent to the Standards Department at Washington for verification, as also was the tape which showed the travel of the piston. Unlike the smaller testing equipment used in this country, this prover consisted essentially of a casing with a travelling piston, the piston being coupled to an hydraulic ram so that its rate of travel could be controlled. The joint between the piston and the cylinder was kept air-tight by means of an oil seal which in turn was kept moistened by an auxiliary oil pump.

When meters of large capacity were being tested they were got up to speed by a fan and by interconnected valves; the air flow from the prover was allowed to pass through the meter being tested. By means of an electric counter, when known numbers of revolutions had been passed by the meter, electric contact was made on the principle of a motor car make-and-break, and the electric current momentarily passing operated a solenoid which had the effect of causing a rider to stop on the scale of the tape denoting the travel of the piston. It was therefore possible to note the volume of air passed by the meter for each ten, 100 or 1,000 revolutions, depending on the capacity of the meter. It was on the basis of these tests that the figure of dividing the slip by half was arrived at.

Dealing next with the comparative results of a wet drum meter against a Connersville meter, it could of course be argued that very little was known about the accuracy of wet meters on their higher range of operation until the advent of the Connersville meter, but it seems to be a characteristic of wet meters that the results tend to fluctuate, due to the turbulence of the sealing medium when the drum is passing through it at the higher speeds.

With regard to the swept volume, the calculated capacity is based on the theoretical size of the measuring cavity, the outline of which can be counted as a line passing between the tip of the impeller and the inside radius of the casing. In other words, a working clearance is allowed on both the impeller and the casing.

Boundary Layer

Referring to the curves (in Fig. 5 of the paper), we carried out a considerable number of tests by driving a meter and so eliminating differential pressure, which confirms the phenomenon shown, namely that the volume of gas slip at very low tip speeds tends to increase until initial inertia is overcome, due, no doubt, to the fact that there is a fundamental difference between gas slipping past a moving impeller and that passing through a stationary orifice, as has been demonstrated by the author. This is well explained by the boundary layer concept of fluid mechanics. With a stationary impeller there will undoubtedly be two separate boundary layers, one adjacent to the casing and one adjacent to the impeller, and the effect will be to reduce the volume slip on two separate substantial counts.

On the other hand, when the impeller tip is moving in the same direction as the gas being slipped the tip boundary layer is modified by some amount dependent on the relative velocities of the impeller tip and the gas slipping past. One could argue that if the forward velocity of the slip governed by pressure differential and the impeller tip velocity governed by gas throughputs were the same, then the tip boundary layer could be regarded as non-existent and not affecting the volume slip at all.

With reference to the outdoor location of Connersville meters, while the Connersville meter will work well out of doors it is desirable that adequate maintenance be carried out under such conditions.

Mr. R. Birch, North Thames Gas Board: As a result of the author's work we can all be reassured and confident that our Connersville meters will measure accurately so long as they are mechanically accurate. In other words, if the meter is made to a good standard we shall have no need to worry about the registration.

Mr. C. P. Henshilwood, North Thames Gas Board: This paper has shown that the Connersville type of meter can be trusted to behave itself well enough to be accepted as a station meter; that sometimes it behaves itself better than a positive wet drum meter. It can thus be inferred that the Connersville meter would be suitable for the sale of gas. In fact, the Ministry of Power has approved it for this purpose, as it has also approved the B.M. meter. This may not be appreciated by members of the Institution responsible for the sale of gas to industry. They might find it rewarding to consider the Connersville type of meter for use in some of their larger new installations, particularly

where the space available for the meter is limited and the meter will operate at rates between capacity and 10% of capacity.

I am also very interested in methods of calibration and in the influence of temperature and humidity.

In the testing of his meters, the author says that he has found that the 'true' gas temperature in a wet meter is very close to the average of the inlet and outlet gas temperatures averaged again with the water temperature. It has been our experience at Watson House that the domestic size of meter makes a good heat exchanger. In a temperature controlled laboratory ambient temperatures, meter case temperatures and, in the case of wet meters, meter water temperatures are all very similar provided suitable precautions are taken. For a wet meter, we have taken the water temperature as that at which gas is measured; this is a value commonly accepted by workers in this country and in America and it has enabled us to obtain consistent results. Such a correction datum may not hold for larger meters, in which an average gas molecule has less of a chance of coming into contact with the material of the meter, or the water in it, because of the meter's larger dimensions. In these circumstances the meter will not function so effectively as a heat exchanger, and it is here that the relationship the author proposes may be taken to hold. This is a valuable contribution to our knowledge and indicates the need for further work to establish what happens in medium-sized meters.

Ambient Temperature

I cannot go into the question of the effectiveness as a heat exchanger of the domestic dry meter, because this would require me to write another paper, but I can say that our tests have shown that we can take the ambient temperature as the true temperature curve for initial calibration of a domestic meter, and, since we quote our results to only $\pm 0.1\%$, temperature variations of $\pm 0.5°F$. can be tolerated. We had hoped that the author would give us more information on the question of humidity, a factor of great importance when using a wet meter. This we have found to be particularly true when a wet meter is placed downstream of the dry meter it is intended to test, and so, in effect, measures the gas flowing through the dry meter, plus an additional amount of water vapour. We have also experienced trouble due to condensation when a dry meter is placed downstream of a wet meter and is as little as 1°F cooler than the water temperature in the wet meter. I should be very pleased to hear from the author about his experience with humidity in dealing with large meters.

Mr. A. E. Haffner, Southern Gas Board, said: The author will be disappointed if we do not introduce a note of discord into this discussion. He says that this is not only a positive displacement meter but incorporates within itself three and sometimes four orifice slip meters. Although gas engineers pay for the Connersville meter, there are other industries which would put their money on an orifice plate and the exponents of orifice plate meters are indulging in an increasing degree of confidence in them.

Meter Agreement

I offer as a small item to this discussion the tale of a tug-of-war between a Connersville meter and orifice plate meters. There happens to be at the Southampton works a Connersville meter which is receiving the primary gas up to 10 lb. pressure and containing 1% of hydrogen sulphide. Then there is a main, 15 miles in length, and on a refinery an assembly of orifice plates in a standardised assembly in which there is a horizontal loop, a two-limbed loop with an orifice plate inserted in each limb. From each of the orifice plates there are two recording meters. These record at high rates and at low rates.

It is a matter of very great importance to us to have agreement between these meters, because this is the basis of sale and any difference is a matter of being in deficit with the Southern Gas Board or making a profit. In the first six months—it took that time to settle down because of instrumental difficulties and getting rid of condensate, so I shall not bring that into the comparison—the Connersville meter was admitted to be the basis of sale and not the orifice plates which, according to the contract, should have been the basis of sale. In a further six months the Southampton meter showed 0.9% less than the Fawley orifice meters. In the last 14 months, with no condensate at all, because of improved cooling at Fawley, the Southampton figure was 0.16% less than the Fawley readings. A recent slip test on the Connersville meter showed it to be 0.36% slow.

Compensated Errors

From all this it is possible to draw a number of conclusions. We may conclude that there are compensated errors and that they have both equal errors, but I prefer the simple conclusion that these two methods of measurement gave comparable results, and consequently that the main was tight.

Mr. Dougill, replying, said: I doubt Mr. Whiteley's statement that before the war almost the whole of our gas was measured by Connersville meters. I do not think that the sale of Connersville meters would be only for coal gas production; they are used to measure air and other gases, and I know that in fact the greater bulk of gas was measured by water meters in most of the works of which I have knowledge.

Mr. Hepworth's contribution was of great interest. I purposely restricted myself, in a paper given at a Research Meeting, to something of the type of a research paper, but naturally he wants to look on this from the point of view of increasing the efficiency of the gasworks and the increasing efficiency in the district.

As regards the temperature of the water being the temperature of the meter, this was only for one particular 250,000 cu.ft. per hour meter. With a large meter the temperature of the gas is further from the temperature of the water and the result which I gave holds only when the temperatures are within 1°F.

Differential Pressure

I should be very nervous about the use of Connersville meters for the sale of gas. In the sale of gas, for a large part of the time a meter is measuring gas in small consumptions to pilot lights and so on. On the question of humidity, as I was on a works and using a wet meter I was bound to use a completely saturated gas and maintain the temperature so that there was neither condensation nor drying. That is a difficulty which has to be accepted if a water meter is used as the standard.

I thank Mr. Haffner for introducing a little discord, although I should not call it that. Orifice meters are good and can be accurate, but they are very much more affected by density of the gas. They all depend on the measurement of a differential pressure. That differential pressure will rarely be more than 5 in. There are very few instruments which will measure that 5 in. to an accuracy of 1%. With all due respect to what may be said about the accuracy of orifice meters I do not think it is possible to expect an accuracy, even under very carefully controlled conditions, of much more than 1%.

25th AUTUMN RESEARCH MEETING

A Recuperative Furnace for Temperatures up to 2,000°C.

By

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and

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THE upward trend in industrial process temperatures, which commenced in prehistoric times, has in recent years become increasingly significant. Higher operating temperatures of items such as jet engines and gas turbines engender, in their turn, a need for test equipment working at even higher temperatures.

Prior to the second world war, reports appeared of gas furnaces of small capacity for which temperatures of 1,800°-2,000°C. were claimed. These were mainly of German origin.

In this country, during the post-war period, an early move in the direction of higher temperatures was reported and this was followed by a proprietary furnace of about 1 cu.ft. of working space, which reached temperatures of 2,300°C. and employed short-cycle regeneration. It was felt that this upward trend would continue, and, therefore, that it would be worthwhile to extend the work at Watson House to a higher temperature range where problems of design and materials would be more severe.

The attainment of the temperature required involves either the pre-heating of the air for combustion, or its enrichment with oxygen. Since the aim was to produce furnaces of industrial size, it was felt that oxygen enrichment would not be economic. It was also thought that should the use of oxygen be required in practice, its introduction would not give rise to practical difficulties to the extent that is normally experienced in providing highly preheated air.

It was decided to aim at an air temperature of 1,000°C., and to this end, it was proposed to construct a high temperature recuperator at the hot end of which refractory tubes would be used; this was regarded as a second, almost independant, project, running in parallel with that of designing the furnace.

The choice of materials for the inner lining of the furnace was, of course, severely restricted. The temperature required was too high to permit the use of alumina, which, leaving aside the expensive special oxide materials such as beryllia and thoria, reduces the choice to magnesia or zirconia.

Magnesia has the very high melting point of about 2,700°C. but is limited in its application because its vapour pressure begins to rise rapidly at temperatures above 1,900°C. It is also a chemically basic refractory, although its reactivity is said to diminish when it is fired to a high temperature. This point affects not only the construction

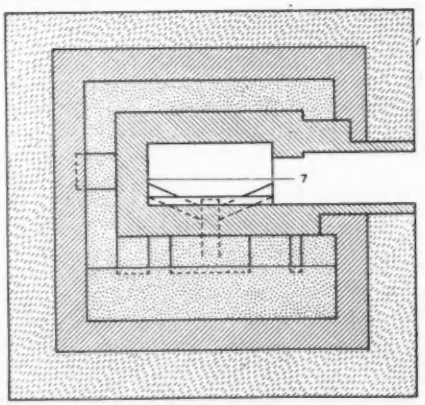


Fig. 1. Cross-section of the furnace.

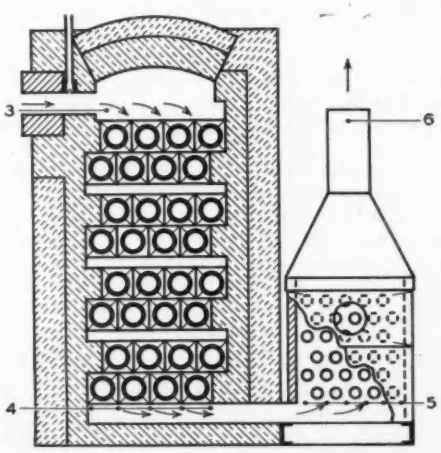


Fig. 2. The modified recuperator.

of the furnace, but also its subsequent use, since reaction may occur with objects placed in the furnace.

Zirconia, on the other hand, is several times as expensive as magnesia, and requires stabilisation against its irregular thermal expansion characteristics. The decision was made, therefore, to use magnesia.

When considering the insulation of the furnace, the use of an outer layer of diatomaceous earth insulating bricks, with aluminous insulating bricks immediately inside it, is standard practice, and was adopted. Unfortunately, no proprietary insulating refractory could be found that would tolerate a higher hot face temperature than 1,600°C.

Rather than use an excessive thickness of the dense magnesia brick in order to avoid exceeding 1,600°C. at the interface, it was decided to try the use of a cavity filled with magnesia powder.

The recuperator was constructed in two parts, using metal tubes for the cool end and refractory tubes for the hot end. Since a change to refractory tubes had to be made, it was decided to use mild steel tubes for the cool end, rather than attempt to extend the metallic portion by the use of heat-resisting steels.

The construction of the furnace is illustrated in Fig. 2.

Powers of Entrainment

Gas was supplied at 5 lb. per sq. in. to a size 60 Hypact burner made from a silicon-ester-bonded zircon, firing obliquely upwards under one side of the roof arch. Hot air from the recuperator was fed to the emergent gas from two openings, one above and one below the burner, giving two streams normal to the plane of the flame, one on each side of it. The high temperature of the hot air, coupled with the considerable powers of entrainment possessed by a high-pressure Hypact burner, gave a flame that was hot and compact and capable of giving the high temperatures sought.

The working chamber had an arched roof in three courses each of three voussoirs. Of these, the central course was unsupported by the walls except where it abutted on the skew-backs. The flue left from below hearth level at the side of the hearth opposite the burner. A doorway, 8 in. by 4½ in. was provided in the front wall, and closed by bricks of similar material to the various courses of the wall.

In order to provide an annular space 3 in. wide to contain the magnesia powder insulation, the inner lining of the furnace had to be carefully supported by 'flying buttresses' of magnesia tile rebated into the aluminous insulating refractory forming the next course.

Upper Temperature Limit

The recuperator was constructed to raise the temperature of the combustion air from room temperature to about 1,000°C. At a later stage in the work, it was found necessary to add some cold air to the hot fuel gases when the furnace temperature exceeded 1,800°C., in order to prevent damage to the recuperator: this gave an upper temperature limit of 1,200°C. to the preheated air. The recuperator was built on a separate base from the furnace, so that either unit could be built independently. In the first design, three passes of steel tubes were placed beneath two passes of refractory tubes. At a later stage, the recuperator was modified by having the two sections side by side, as shown in Fig. 2.

Services to the furnace were as follows:

(i) *Gas*

Gas was available either from a low-pressure source, which sufficed for temperatures up to 1,650° to 1,700°C., or from a compressor yielding 5 lb./sq. in. for the higher temperatures. Appropriate controls and interlocks were used to prevent the high-pressure gas being fed back into the lower-pressure supply, and to cut the gas off should the air supply fail.

(ii) *Air*

Air was available at 1 lb./sq. in. but the inlet pressure to the recuperator never exceeded 1.3 in. w.g.

(iii) *Induced Draught*

In order to give some control over the pressures in the furnace and recuperator, an eductor was fitted to the cold flue gas outlet from the recuperator. This was fed from the same air supply as the combustion air.

The performance is summarised in Table 1.

TABLE 1.
FURNACE PERFORMANCE

Working Chamber Temperature (°C) 1	Preheated Air Temperature (°C) 2	Heat Input (therm/h) 3
1,505	630	0·61
1,640	690	0·81
1,790	1,060	1·35
1,855	1,100	1·75
2,000	1,250	2·07

No attempt was made to achieve rapid heating of the furnace, and about 48 hours were always allowed for 1,650°C. to be attained; from this temperature to 1,850°C. took 4½ hours, and from 1,650° to 2,000°C. about six hours.

The furnace and recuperator had a high heat capacity and always required to be left overnight at a steady heat input in order to attain equilibrium. When the gas was turned off, it was necessary to wait four to five days before a gloved hand could be inserted into the furnace, and eight to ten days before work could comfortably be carried out.

Comparative Values

In studying the temperature distribution in the walls, it was found that the powdered magnesia layer appeared, unexpectedly, to have poorer insulating properties than the solid magnesia brick. The magnesia powder, however, became sintered into a firm mass, and comparisons made between this and the solid magnesia brickwork of the inner wall showed that the apparent porosity of the sintered powder was 40.3%, while that of the solid brick was 23.6%.

These values indicate that the magnesia powder should have been a considerably better thermal insulator than the solid magnesia. The only explanation so far advanced for this paradox is that the pore size in the solid brick was smaller than in the sintered powder.

The history of the recuperator falls into two parts. The unit as first constructed was used for about nine months, during which period the working chamber of the furnace was held at about 1,650°C., with the exception of two short periods totalling five hours when the temperature was increased to 1,800°C.

At the end of this period, the top row of the hottest pass of steel tubes failed, and replacement became necessary. It was found that the construction adopted necessitated the complete dismantling of the refractory portion of the recuperator in order to remove the steel tubes, and, moreover, that the inter-locking ends of the refractory tubes were difficult to separate. This was taken as evidence that the special shape of these ends had been successful in minimising movement and leakage between tubes, but it also meant that attention to the steel tubes involved considerable breakage of otherwise sound refractory tubes. It was decided that the unit had reached its upper limit of working temperature, and arrangements were therefore made to temper the hot products of combustion by introducing cold air to the main flue. This would be necessary whenever the working chamber temperature exceeded 1,850°C. and

was controlled to restrict the preheated air temperature to about 1,200°C.

Comparisons of the two recuperator patterns are given in Table 2.

TABLE 2.
COMPARISON OF RECUPERATORS

	Original		Modified	
	Refractory	Mild Steel	Refractory	Mild Steel
1	2	3	4	5
Number of tubes	16	42	32	30
Number of tubes in each row	4	7	4	5
Number of rows in each pass	2	2	2	3
Number of passes	2	3	4	2
I/D of tubes	2·25 in.	1·39 in.	2·25 in.	1·42 in.
O/D of tubes	3·25 in.	1·68 in.	3·25 in.	1·67 in.
Wall thickness	0·5 in.	0·14 in.	0·5 in.	0·13 in.
Area of cross-section	0·028 ft²	0·011 ft²	0·028 ft²	0·011 ft²
Effective tube length	31 in.	31 in.	31 in.	31 in.
Heat transfer area	29·75 ft²	35·5 ft²	59·5 ft²	28·6 ft²
Minimum products flow area	1·24 ft²	1·82 ft²	1·08 ft²	1·53 ft²

The paper concludes with a critical survey of the recuperator performance. It was found that the average overall heat transfer coefficients of the two sections of the recuperator were: Refractory tube section, 0.64 B.t.u. per sq. ft. per hour per °F.

Steel tube section, after fitting baffles in the space outside the tubes, 1.28 B.t.u. per sq. ft. per hour per °F.

The survey includes an assessment of recuperator leakage and a study of flow patterns.

Before coming to any decision concerning the future of this design of furnace, further runs at 2,000°C. are required to obtain further experience at such temperatures. At this stage, the furnace should be used to assess other materials of construction, the most important being zirconia. In view of the difficulty of stabilising zirconia properly, it is desirable that material from any source that it is proposed to use should first be examined in this respect and also subjected to the full temperature it is required to withstand.

The recuperator will not need redesign unless appreciably higher temperatures are required or further use reveals unsuspected weaknesses. Further development might well lead to a more compact unit by attention to the flow paterns and the disposition of the heat transfer surfaces.

DISCUSSION

Professor A. L. Roberts: I am sure that we shall all warmly welcome this bold and adventurous excursion into a range of furnace operating temperatures that has hitherto been virtually a no-man's-land for the application of town gas. The authors say that furnace equipment working at 1,800-2,000°C. must be made available to keep abreast of demand and, better still, one jump ahead. I can certainly endorse that claim from my own experience. Interest in furnaces of this sort is growing rapidly, in keeping with the vigorous development of high-temperature engineering materials such as carbides and pure-oxide ceramics. With such materials, testing and fabricating temperatures of 2,000°C. and above are now commonplace, and if these temperatures can be achieved by gas firing, so much the better for the user and for the industry.

It should be clear from what the authors have said that catering for temperatures of 1,800°C. and over, brings major problems which the authors have faced fairly and squarely. Preheating the air for combustion is essential, and at temperatures which call for the use, at least in part, of non-metallic recuperator tubes; in this connection I think that the authors have made an ingenious essay in solving a difficult problem. The combination of the refractory hot end with a relatively cold metal end is indeed most ingenious. In these developments, however, there is always the problem of materials which, for this temperature range, are severely restricted, and I shall come back to that. In the meantime, we can welcome this newcomer which provides such temperatures of 1,800 to 2,000°C. in a usefully-sized working space at something about two therms an hour—a remarkably low gas consumption, as the authors point out.

On materials, I would like to comment especially on the use of magnesia powder as an insulating filling behind the working face. The use of insulating powders at such temperatures is something of a novelty. The theory behind it is well worked out, but there is the difficulty of putting theory into practice. The difficulties that the authors have had to face do, once again, pinpoint the need in this respect for an insulating refractory capable of withstanding temperatures above 1,600°C. I think I might mention that, largely promoted by Mr. Andrew and his colleagues, co-operative work between Watson House, the West Midland Research Station, ourselves at Leeds and a manufacturer has been initiated by the Gas Council in the hope that appropriate materials can be developed quite quickly.

Teaspoonfuls of Leakage

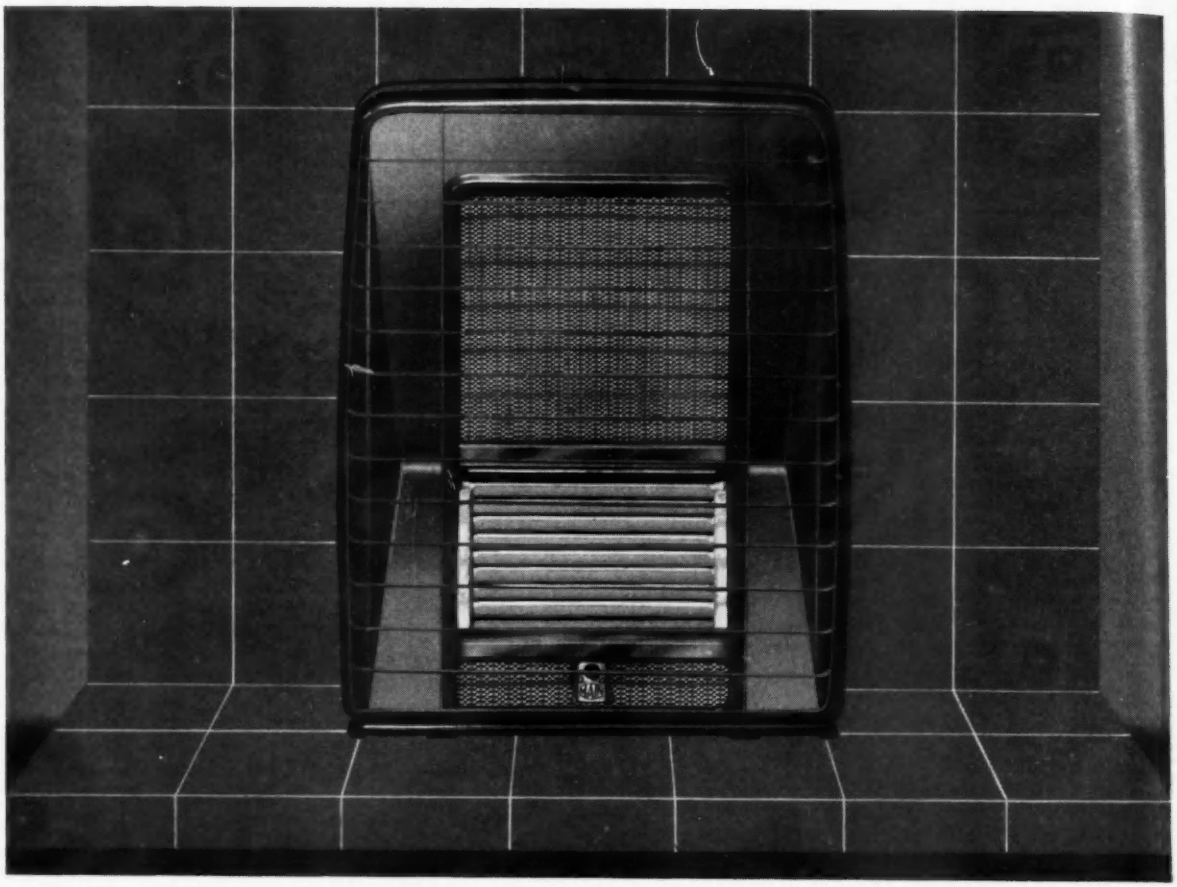
There is no difficulty here in knowing what we want in the brick, because the theory is well-established. The difficulty lies mainly in transmitting the theory into practice on a commercial scale. The authors have paid particular attention to the use of powdered magnesia as a loose fill, naturally anticipating trouble from leakage. I must say that I enjoyed their homely way of measuring leakage. They said that they had only got two teaspoonfuls of leakage! These difficulties did not materialise to any great extent; rather, they found unexpected effects which, I think, arise from the nature of the powder itself rather than from the use of a powder as such.

The measured temperature gradients [in Fig. 10 of the paper] suggest that the thermal conductivity of the loose fill is substantially higher than that of the dense brick. In fact, it looks as if the difference in conductivity is about three times. While one cannot query the measured temperatures—except in so far as that, as the authors say, there may be some doubt about the optical method of measurement—the implications of the temperature gradients upon the thermal conductivity may be misleading. It is important to remember that in this design of furnace—a small working space surrounded by a large area and volume of brickwork—shape factors are important. Heat flowing through a narrow area of the inner lining is spread over areas which become successively greater the further the lining is moved from the working space.

That is purely an academic point, but the sintering of the powder is a factor of much more practical moment. Obviously, it must tend to reduce the insulating power of the filling, both by increasing the actual conductivity of the material itself and also, through the shrinkage accompanying sintering, producing an air space which would have virtually no insulating power at the high temperatures in question.

The interesting point is why the material should sinter at all at 1,600°C. or so. The reason is rather subtle, quite academic, but none the less important, I think, in this practical connection. We have recently found that under certain conditions, magnesia, even when previously heated to quite high temperatures, may contain an imperfectly crystalline phase, and it is this that causes sintering. Without it, the material would not sinter at about 1,600°C. I therefore suggest that it might help the authors in their future work to make sure that their magnesia powder is entirely crystalline. Apart from this, however, the authors might care to consider the use of zirconia—stabilised—powder, since the inherent thermal conductivity of zirconia is so much less than that of magnesia.

Main...



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This is bold, pioneering work in a difficult field. We well realise, with the authors, that three hours trials at 2,000°C. cannot do more than indicate how the furnace will behave under prolonged periods, but at least it has indicated the weaker points of design and, I think, has laid sure foundations on which the authors can build with confidence.

Mr. J. A. Swain, Incandescent Heat Co. Ltd., said: I was particularly intrigued by the opening sentence of the Communication: 'A recuperative furnace has been constructed and shown to be suitable for temperatures up to 2,000°C. I learned later, however, that the furnace had operated at *about* 2,000°C. for only three hours, and the main operating history was concerned with operating temperatures around 1,650°C., which is an entirely different matter. Industrial furnaces for temperatures up to 1,750°C., having work chambers three times the size of the experimental unit described, and equipped with a recuperative system, have been in operation for many years. There is a tremendous difference in requirements when operating above 1,800°C.

The report seems to be a very honest factual statement, presented clearly and concisely, and credit is due to the authors and the courageous work of the operators. There are two matters on which constructive comment might be made. First, on the performance of the recuperator, it would seem advisable to eliminate the metallic section entirely, as trouble will undoubtedly continue with outgoing exhaust gases at such a low temperature, particularly when using large quantities of excess air for dilution. This would enable the development of a high temperature recuperator to proceed unhindered. I might suggest that an air preheat of some 1,500°C. should be the first target.

Secondly, while I believe the authors were correct—when their project commenced—in their doubts about the technique of stabilising zirconia, I am now of the opinion that important advances have been made which might be worthy of investigation.

Work on temperature measurement is vitally important.

The industrial furnace mentioned in the paper employing short-cycle regeneration as distinct from a recuperative system for preheating the air, has a work chamber seven times as big as the unit at Watson House, but consumes only three times the gas rate when operating at 2,000°C. A normal cycle is about 10 or 12 hours heating with a two to three hours steady temperature at 2,000°C. before furnace cooling. Apart from the major problem and expense of maintaining the furnace lining, there are no operational difficulties whatsoever. The maximum temperature attainable would probably be 2,500-2,700°C. if the refractory suppliers could oblige with suitable materials.

Future Work

As a general recommendation, it would seem that future work should endeavour to establish a reliable hot-face lining and refractory construction capable of being heated and cooled many times with a temperature of 2,000°C., which should be held for a minimum of two hours under steady conditions. Concurrently, the development of an all-refractory high-temperature recuperator should continue.

Professor Tring: I must agree with Mr. Swain that other people have come into this field to some extent. Partridge, at Wembley, had a furnace with which he got high temperatures, for the commercial manufacture of glass, using alumina tubes for the recuperator. I do not think that that, however, detracts at all from the paper, because the authors have boldly made their own progress. Their particular contribution has, I think, been on the aerodynamic side, on the burners and the flow of gas in the recuperator, all of which are very important subjects. They are what might be called the second stage of design of furnaces; after one gets refractories that do not melt, and burners that burn, one gets the aerodynamics right.

They have also looked into air leakage, which is obviously the bugbear of a furnace such as this, particularly in the recuperator, and have been remarkably successful in achieving a preheat of 1,200°C., which is probably as good as the result with any recuperator that I know of. But what a pity they could not go higher, because if one is going to heat a furnace to 2,000°C., the waste gases have to go out at that temperature, so why not preheat the air to 2,000°C. and go the whole hog? In other words, why not make the recuperator of the same material as the furnace and try for the limit? There are other points like that that one could mention.

The authors used standard recuperator shapes, which are not absolutely ideal. The authors found that those they used sagged in the middle when they got hot. I am sure that they will agree that the design could be improved.

If one is to use an insulating powder it must be a coarse material. Any fine material will sinter and there will be a reduction in the heat-transfer coefficient. One must use $\frac{1}{8}$-in. or $\frac{1}{4}$-in. material and put plenty in so that it cannot just sink and leave gaps. That applies to any material, and it is terribly important for the intermediate zone.

Bottleneck to Heat Transfer

Another very important point in the paper is the fact that the heat-transfer coefficient in the recuperator was very carefully measured, and that the authors found that it was more than doubled at the higher rates of flow. That seems to indicate that the bottleneck to heat transfer in the recuperator is on the gas side, or the air side, and not in the refractory; therefore, the thickness of the walls of the recuperator is not causing serious resistance to heat flow and the recuperator is not heavily overloaded. That is very important, because the objection raised to refractory recuperators is so often that the walls are too thick and the heat cannot get through. This work seems to indicate that that is not so.

In conclusion, I hope that the authors will now try to get higher than 2,000°C. It is extremely important to know what is the limit of temperature that can be produced in this way. We have not reached the limit yet, and it would be very valuable to do so.

Mr. J. F. Clements, British Ceramic Research Association, said: There are, perhaps, one or two points on which the design might be criticised. It would seem, for instance, that the insulation is almost too good, for the extremely long cooling time would be a serious disadvantage in most applications. Efficient insulation is no doubt essential, since the furnace must work at high efficiency, and the problem of slow cooling would have to be attacked by reducing the heat capacity of the structure.

If the authors carry out their projected investigation of the possibility of using zirconia as a lining material, they will probably solve this problem and a number of others, too. At present, they will probably have to look to the United States for their refractory materials but, in due course, manufacturers in this country will probably be able to supply suitable products. Incidentally, the Americans now seem to be quite satisfied that their stabilised zirconia is permanently stable. The authors may be interested to know that the latest price quotation for zirconia is £5 4s. 6d. per brick.

I showed this paper to Mr. Holmes of the fuel department of our Association, and he calculated the effect of replacing the author's rather massive wall structure by a two-layer wall consisting of $4\frac{1}{2}$ in. of zirconia bricks backed by $4\frac{1}{2}$ in. of an American Group-30 insulating material. In such a design, the heat loss would be approximately twice that of the present construction but,

if this could be tolerated, the authors would have a structure in which none of the components was overheated.

I imagine that the overheating of the insulation was foreseen, since a simple calculation of steady-state temperatures in the wall, based on probable thermal conductivity, gives figures near 1,900° and 1,700°C. for the hot-face temperatures of the alumina and diatomite layers, although these would be slightly reduced by the shape factor. I assume that the authors hoped that the resulting shrinkage would be confined to a narrow zone near the hot face of these bricks. In our experience, the very great loss in insulating power of overheated diatomite results in progressive overheating throughout the brick, and the same is true, to a lesser extent, of high-temperature insulation. We should expect to see a progressive loss of efficiency in this furnace if used repeatedly at 2,000°C.

If the authors have reason to adhere to the multi-layer structure, I would suggest that they consider using zirconia as primary refractory, since this would simplify the insulation problem by reason of its low thermal conductivity. They might then consider the use of bubble alumina bonded with alumina cement for the first layer of insulation. The properties of this material are still unknown, but I do not think that its high refractoriness is in doubt. A steady-state calculation would then show whether diatomite could safely be used for the outer layer.

The authors are to be congratulated on their solution of the problems associated with recuperation, which have proved the downfall of many other high-temperature furnaces. In this connection, also, zirconia in granular form might solve their flueway problem.

Removable Bases

Finally, I should like to ask the authors if they have considered how objects are to be fired in this furnace. So far, it appears that they have been concerned with furnace efficiency and performance and have not had to face the difficulty that inevitably arises at temperatures near 2,000°C.; namely, that any material will react with practically any other material. For instance, the number of substances that could be fired on a zirconia base at 2,000° is very limited. One may eventually have to resort to providing a variety of removable bases to match the materials to be fired. The base would be isolated from the walls, and would pass through the hotter parts of the structure, resting on the lowest insulating layer. If the furnace has to be reconstructed, the authors might be well advised to make provision for an arrangement of this kind.

Mr. E. A. K. Patrick, in reply, said: One point he made which seems to call for discussion is that the thermal conductivity of a loose filling of magnesia powder was higher than that of solid magnesia bricks. That is quite true, and obviously so. Incidentally, we measured the bulk density after sintering, and it was definitely still lighter than the solid bricks. We were rather inclined to attribute it to the fact that, largely for the sake of economy, we had used a powder sized down to zero. All the fines had not been taken out, so we assumed that the pores had been filled. It is our intention to use a much more closely graded powder, and we shall also have to inquire into the form of the powder.

Mr. Swain raised the point that the furnace had been heated to 2,000°C. only for three hours. We designed it as a 2,000°C.-furnace, and the fact that we ran it at that temperature only for three hours was due to our caution. We wanted to find out as much as possible about the performance of the recuperator at the lower temperatures before risking damaging it at the higher ones. However, we feel that three hours is a respectable period. It was one run, which means that the structure had a fair chance of getting soaked through and allow us to check on weaknesses. We would like to use it for very much longer runs at 2,000°C., and shall do so.

That may have a bearing on Mr. Swain's second point about the metallic section of the recuperator and corrosion. When we get the furnace up to 2,000°C. I do not think that the recuperator will be working at such a low temperature.

We certainly have the use of zirconia in mind. Since we first planned the work, a lot has happened in the field of zirconia, and we are certainly hoping to get some—if we can afford it—which will be reasonably stabilised.

Mr. Swain also mentioned a proportionately lower gas rate. Surely, this is to be expected. When one is feeding a furnace at temperatures like this one has wall losses. Particularly in these high-temperature furnaces with their very thick walls, the ratio of the outside surface area to the working face will diminish quite considerably as one increases the size of the furnace.

Professor Tring referred to the use of oxygen by Dr. Partridge. Our feeling is that at present, if one wanted to use the furnace regularly for production, one would probably say that the use of oxygen was too expensive and therefore, would probably prefer a recuperator. We also felt at the time that the recuperator would be a very interesting exercise of itself; and that we ought to do some work on high-temperature recuperation. It sounds easy to use oxygen to get these temperatures.

Most of the few furnaces that have been made for operation at this temperature have been made for laboratory purposes. In a laboratory, there is much less trouble in using oxygen, as one probably operates the furnace only once in a fortnight, and that makes the cost tolerable. However, we intend to start, as a preliminary run in the development of this preheated air system, to do some work on the attainment of high temperatures with oxygen, as that is a subject to which the gas industry, at least, has not given a lot of thought. One uses oxygen with fuel gases for cutting and welding, but not for heating, and work has to be done there.

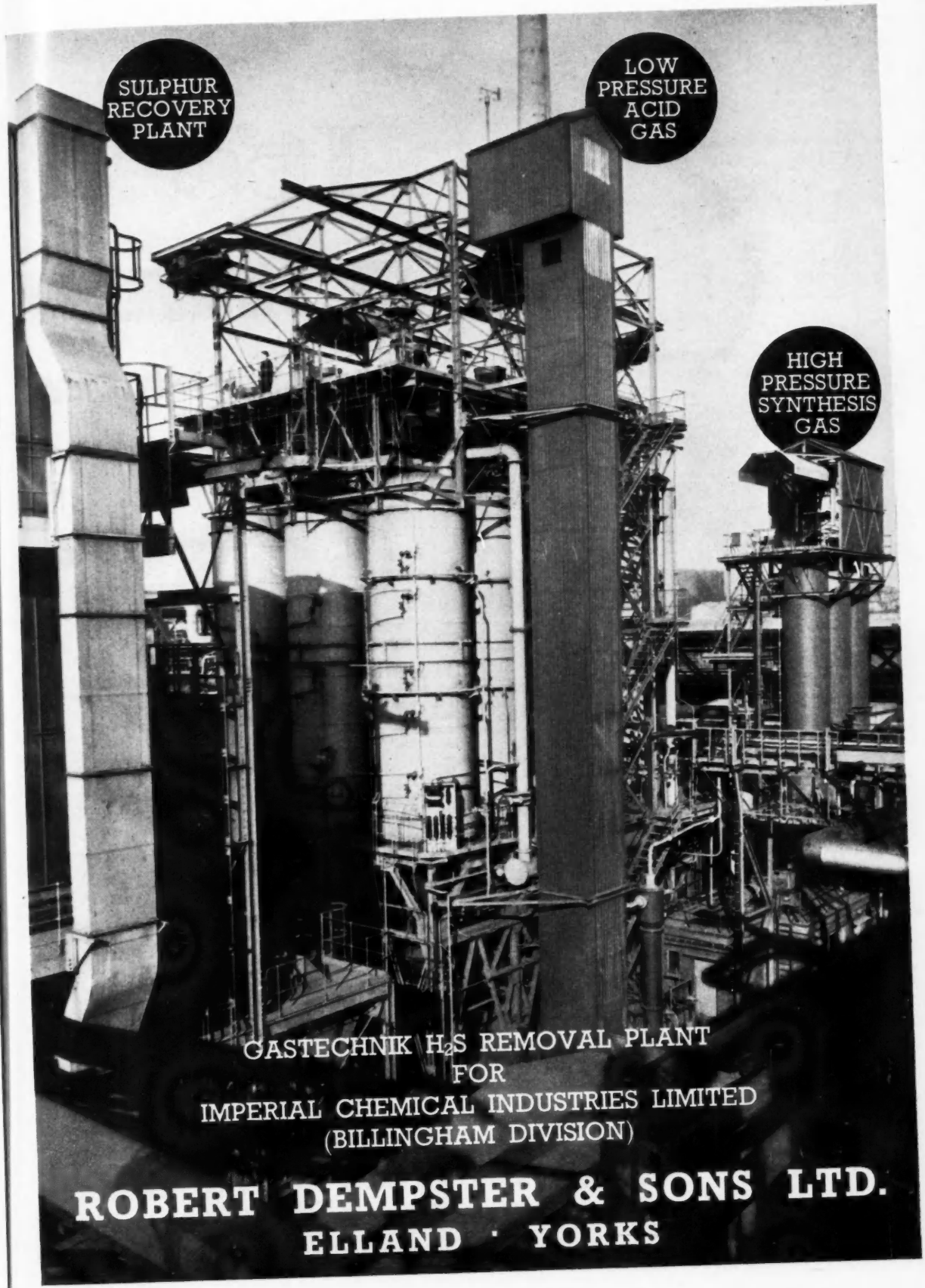
Mr. Clements wants us to reduce our insulation, in the hope of getting a quicker response in increase or decrease of temperature. That, obviously, is one way to do it—and probably the only way—but this is for us a first essay into high temperatures and there are many things to try. We rather concentrated on getting the temperature and see what we could do about speeding up the process at a later stage.

I am glad to know that the Americans have some stable zirconia bricks at £5 4s. 6d. a brick, but that is not a surprise. We have been offered material in this country that seemed to work out at about £4 10s. 0d. I cannot say much more on than subject.

Considerable Confidence

Mr. Clements' colleague calculated that the hot face would attain 1,700°C. He must have considerable confidence in his physical data. I would not like to calculate it until we had done the work and got some data on the thermal conductivity. I do not honestly believe that our hot-face insulation has been to anything like that temperature. It has certainly been overheated. but not up to 1,700°C. We had in mind using zirconia for an inner lining using, possibly, alumina bonded with alumina cement which now offers itself as an obvious try in place of all, or some of the powdered insulation laying.

How could the furnace be used? I would suggest, in relation to the isolated base, that there is not much one could put in a furnace lined with magnesia. I have no great experience of zirconia. But everything reacts faster at those temperatures. We are limited at the moment to zirconia or magnesia so we must do our best with what we have.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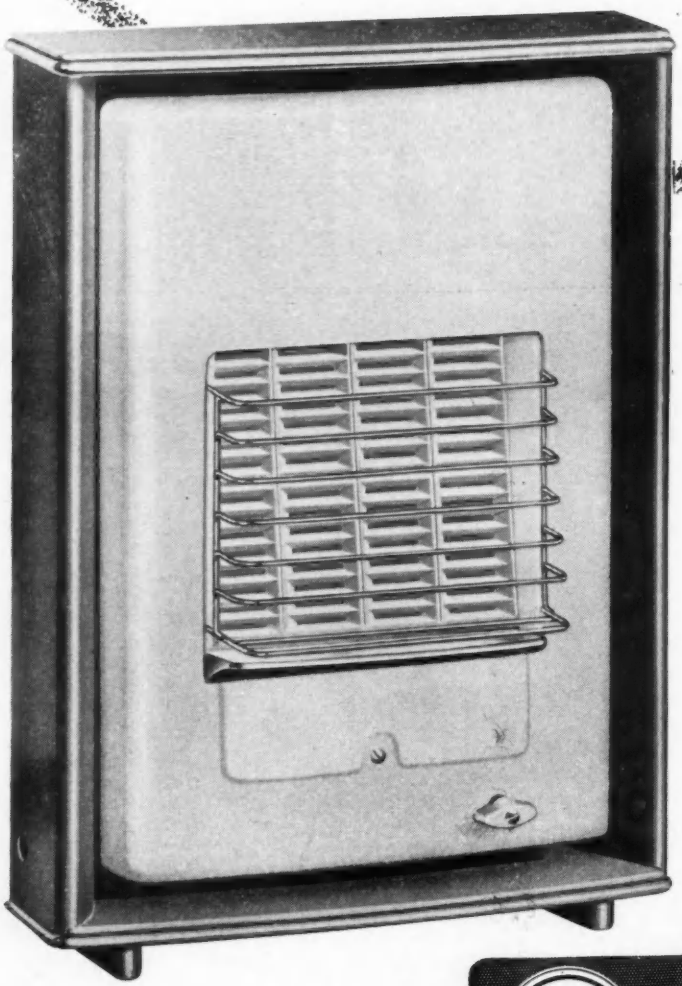

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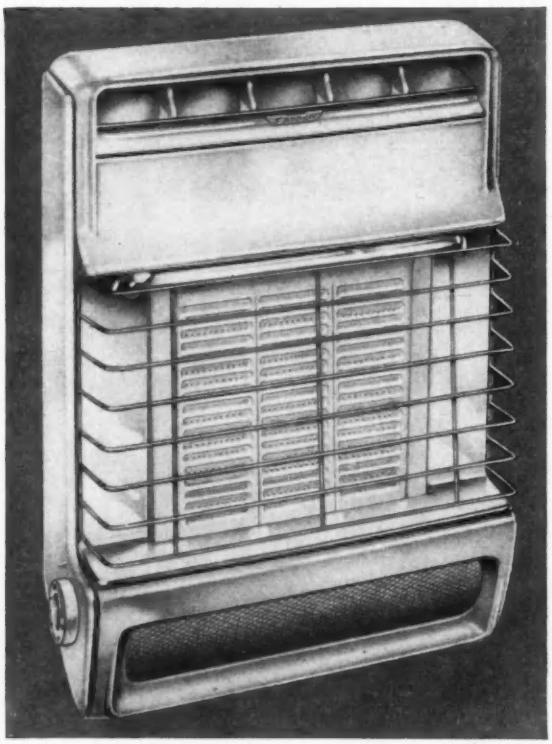

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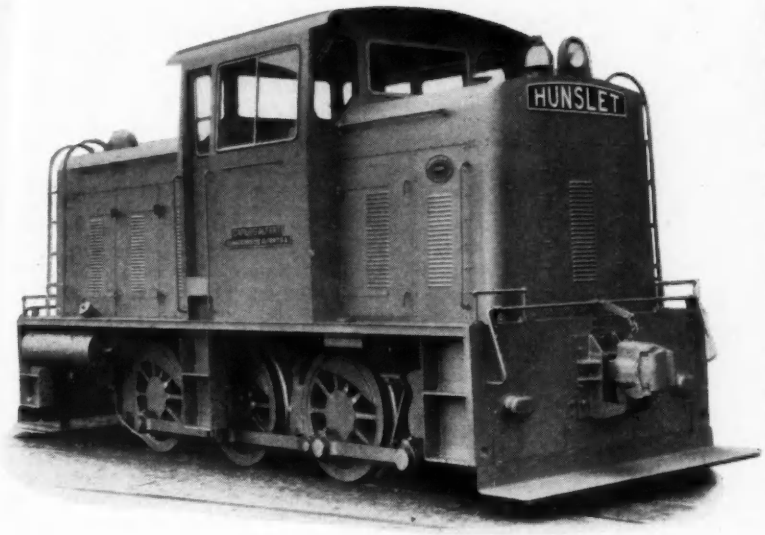

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The driver is considered at every stage of design and construction. He is provided with a roomy, comfortable cab, mounted towards the centre of the locomotive. This, combined with the provision of generous window space, ensures first class all round visibility; a valuable safety feature which also increases the speed of working. The central position of the cab enables the floor to be completely flat, giving unobstructed movement between the driving positions on either side. It also provides admirable maintenance accessibility, the engine and transmission being situated entirely within the two end compartments.

Smooth braking

The controls, which are duplicated on both sides of the cab, are power assisted and are conveniently mounted on a desk facing the short end of the locomotive. They include a powerful straight air brake, actuating cast-iron brake blocks on all six wheels. Control of the train is not, however, solely dependent on the air brake, for a converter/fixed drive control is provided so that the converter can be dispensed with at will and the full power of the diesel engine used to assist braking. Tests of Hunslet diesel hydraulic locomotives in service have proved that the smooth operation of engine braking gives a vast reduction in stopping distances, particularly under greasy rail conditions. This is of great importance in view of the immense loads which can be started by a diesel hydraulic locomotive where the initial tractive effort is limited solely by adhesion.—*Hunslet Engine Co. Ltd., Hunslet Engine Works, 125, Jack Lane, Leeds, 10.*

TRADE NEWS

New B.O.C. welding blowpipe available

A NEW welding blowpipe of exceptional lightness is now being marketed, manufactured by British Oxygen Gases, Ltd.

The new blowpipe is an extension to the company's range of equipment, specially developed for welding sheet metal and for light welding repairs, such as to car bodies and fittings. It was seen by the public for the first time at the Motor Show, held recently at Earl's Court.

Known as the Light Weight Saffire, the blowpipe, completely assembled to include one of the standard range of nozzles, weighs only 9½ ounces. It has forward-mounted controls for easy adjustment, and is 13¼ in. long.

Mixer assembly

The blowpipe has a new type of mixer assembly specially designed to provide a stable flame and resistance to back-fires over the whole working range. The normal range, which is covered by six nozzles, permits welding of sheet steel up to $\frac{3}{32}$ in. thick, but three additional nozzles are available for thicknesses up to $\frac{5}{16}$ in.

The inlet construction and valve blocks are machined aluminium stampings, while the gas tubes are drawn aluminium. The handle valves are aluminium die castings, and the assembly is finished by polishing and clear anodising.

Gas control valves are of the fine adjustment type, with stainless steel spindles. The gland caps are of polished chromium plated brass. The control knobs, which are fluted in shape, are made of anodised aluminium suitably colour coded. The length of the shank is 6⅞ in. and its weight 6¼ ounces.

The assembly follows the basic Saffire pattern and, compared with existing lightweight blowpipes, is of an improved design which results in better gas mixing and greater resistance to back-fire. It is made entirely of brass.

. . . regulators, too

A NEW range of single-stage oxygen and acetylene regulators is now available from the company. Of sturdy construction, they have been subjected to rigorous field trials at home and overseas.

The new regulators, S.O.R.1 and S.A.R.1, which were exhibited at the Motor Show, complement the company's P.R.1 propane regulator, which has been on the market since January last year.

Designed for rough service conditions where very fine pressure adjustment is not required, these inexpensive regulators weigh only three pounds in spite of their robust construction. They are intended for use in heating and cutting applications, and are considered particularly suitable for general cutting and 'on-site' work.—*British Oxygen Gases, Ltd., Spencer House, St. James's, London, S.W.1.*

INCREASING DEMAND FOR TEDDINGTON'S INDUSTRIAL BELLOWS

TEDDINGTON AIRCRAFT CONTROLS LTD. reports an increasing demand for its large bellows assemblies in stainless steel, both rectangular and cylindrical. Cylindrical bellows of 6 ft. dia. are being produced in quantity and 9 ft. and 10 ft. units are at the drawing board stage.

The expansion in this part of the business has caused the company to look for larger premises with adequate handling facilities, and they have now taken over from the Steel Company of Wales a disused tinplate works at Pontardulais, near Swansea. The modification and modernisation of this large factory of 78,000 sq. ft. may well take another 12 months to complete, but a small portion of the heavy work has already been transferred to the new site and the rest will gradually follow. Meanwhile, production continues at the Ammanford (Carms.) works.—*Teddington Aircraft Controls Ltd. (Industrial Bellows Div.). Ammanford, Carms.*

Corner tube boiler license agreement

NEWTON Chambers & Co. Ltd., of Thorncliffe, Sheffield, have entered into a licence agreement with Corner Tube Boiler Co. Ltd., of Manchester, for the production and sale of corner tube boilers in Great Britain.

The use of these boilers will extend the application of the Redfyre Emma coke-fired central heating boiler from hot water and low pressure steam, to the higher pressure steam and hot water requirements of large buildings, hospitals and industry.

Babcock and Wilcox Ltd., who already manufacture corner tube boilers in this country, will continue to do so, dealing with the very large boilers for steam raising, while Newton Chambers & Co. Ltd., provide the hot water systems and medium size high pressure steam boilers. —*Newton Chambers & Co., Ltd., Thorncliffe, near Sheffield.*

PRESSURE REDUCING VALVES FOR ALL INDUSTRIAL USES

A NEW range of pressure reducing valves, in sizes from ½ in. to 2 in., is announced by a Yorkshire company. The valves, known as Type 470, can be applied to all factory and industrial services—steam, gas, air, or liquids—and are of a simple yet reliable design which enables them to be priced reasonably.

The valves are generally constructed of heavy bronze castings, but the wearing parts, in all sizes, are made of stainless steel, and an integral strainer prevents the entry of dirt, scale, or other foreign matter which would cause injury to the seating. Maintenance is therefore negligible, yet, when necessary, it is easy to effect—an important consideration, as valves of this type are often under the control of operatives who are not skilled engineers.

Although simple in construction, the valves operate with remarkable efficiency. Irrespective of flow demand there is only slight downstream pressure variation up to the maximum rated capacity, and a tight closure when there is not demand. There is negligible variation of downstream pressure due to variations in supply pressure, and complete absence of 'chatter.' The spherical valve is practically self-cleaning and the metal seating is renewable.

The valves are suitable for upstream pressures up to 250 p.s.i. for steam, or 300 p.s.i. for air or water, and operate at total temperatures up to 450°F. The maximum downstream pressure is 150 p.s.i. for the ½ in. and ¾ in. sizes and 125 p.s.i. for other sizes. Pressure alterations are made by simple screw adjustment. A comprehensive illustrated leaflet, giving full information about construction, installation, operation, maintenance, and valve size selection, is available from *Samuel Birkett Ltd., Queen Street Works, Heckmondwike, Yorkshire.*

Simon-Carves and Société Proabd combine

SOCIÉTÉ Proabd (France) and Chemical Engineering Wiltons Ltd., (subsidiary of Simon-Carves Ltd.), recently reached an agreement to pool their technical knowledge and resources in their special field of chemical engineering. In the United Kingdom and the Commonwealth, they are now trading as Chemical Engineering Wiltons Ltd.

Proabd (England) Ltd., will cease to operate as soon as their current contracts are completed. The Société Proabd of Nancy (France) will continue to operate in Europe.

PRICE REDUCTION FOR T.L.C. GEAR

LANCASHIRE Dynamo Electronic Products Ltd., of Rugeley, Staffordshire, announced the introduction of substantial price reductions for their new T.L.C. transistorised level control equipment recently.

Field experience in widely varying conditions has proved the equipment to be completely satisfactory on a wide range of liquids and solids at varying temperatures and pressures—granite, hot cement, coke, lime, flour and hydrochloric acid are a few of the materials with which this equipment is being used.

The transistorised level control is now in quantity production and orders can be executed promptly. The new price for a single level installation varies between £25 and £35 and for a multi-level installation from £45 to £65 according to the type of probe used.—*Lancashire Dynamo Electronic Products, Ltd., Rugeley, Staffs.*

AN ANTI-SEIZE VAPOUR BOND

ONE way of creating a solid lubricant film is to use Moly-Vapour-Bond. The manufacturers claim that this will prevent scoring, makes difficult parts fit easily, and is particularly suitable for mounting of anti-friction bearings and for press fits.

The Bond is suitable as an anti-seize material for hot and cold screw threads, e.g., turbine and boiler studs, power screws, bolts on chemical plant, taper cocks and plugs.

For dry lubrication, Moly-Vapour-Bond is suitable for wood-working, food, textile and printing machinery and other applications on which the use of oils and greases is undesirable.

Parts coated with the Bond before assembly, say the makers, will run-in without the usual welding and shearing of surface peaks, known as wearing-in, which may occur when using conventional lubricants.

The Moly-Vapour-Bond has an operating range of from −200°F. to +700°.F. —*K. S. Paul (Molybdenum Disulphides) Ltd., Great Western Trading Estate, Park Royal Road, London, N.W.10.*